# Named Temporal Graph Classes in the Literature

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**Abstract**

This note inventories named temporal graph classes that have explicit definitions in the algorithmic temporal-graph literature. The scope is finite discrete-time temporal graphs. The inventory is intentionally conservative: it includes named temporal restrictions and named hybrid classes such as temporal interval graphs, but it does not pretend that there is a finite list once one also counts every schema of the form "each layer belongs to a static class $\mathcal{C}$" or every bounded-parameter family. Those open-ended schemas are discussed separately.

## 1 Scope and Model

We work with a finite temporal graph $\mathcal{G} = (V, E, \lambda)$, where $V$ is the vertex set, $E \subseteq \binom{V}{2}$ is the footprint edge set, and $\lambda : E \to 2^{[\tau]} \setminus \{\emptyset\}$ assigns each edge its set of presence times. Equivalently, the $t$-th layer is $G_t = (V, E_t)$ with

$$E_t := \{e \in E \mid t \in \lambda(e)\}.$$

We write $G_\downarrow = (V, E)$ for the footprint. A temporal path is a sequence of time-edges whose underlying edges form a static path and whose times are non-decreasing; it is *strict* if the times are strictly increasing [KKK02; Mic16].

The term "temporal graph class" is unfortunately overloaded. In the literature, it may mean at least three different things.

- A named restriction on temporal evolution, such as $p$-monotone or $\lambda$-steady [Flu+20].
- A named hybrid class obtained by combining the temporal model with a static graph class, such as temporal interval graphs or order-preserving temporal unit interval graphs [Flu+20; Her+22; Her+23].
- A schema that generates infinitely many classes, for example "temporal $\mathcal{C}$-graphs" for arbitrary static classes $\mathcal{C}$, or families of graphs with bounded temporal neighborhood diversity or bounded temporal cliquewidth [Enr+24].

The main inventory below covers the first two categories. The third is discussed in Section 7. I also exclude the separate distributed *time-varying graph* hierarchy, which has its own class system based on recurrence and periodicity assumptions [Cas+13].

## 2 Inventory Table

| Class | Defining idea | Standard source |
|---|---|---|
| $p$-monotone temporal graph | The lifetime can be partitioned into $p$ contiguous blocks, each monotone by edge-set inclusion. | [Flu+20] |
| Grounded temporal graph | Some layer contains all other layers' edge sets. | [Flu+20] |

| Class | Defining idea | Standard source |
|---|---|---|
| $p$-periodic temporal graph | Layers repeat with period $p$. | [Flu+20; Cas+13] |
| $T$-interval connected temporal graph | Every window of $T$ consecutive layers has a connected edge-set intersection. | [KLO10; Flu+20] |
| $\lambda$-steady temporal graph | Consecutive layers differ by at most $\lambda$ edge insertions or deletions. | [Flu+20] |
| Temporal interval graph | Every layer is an interval graph. | [Her+23] |
| Temporal unit interval graph | Every layer is a unit interval graph. | [Her+22; Her+23] |
| Order-preserving temporal interval graph | All layers admit interval models consistent with one common vertex ordering. | [Flu+20; Her+23] |
| Order-preserving temporal unit interval graph | All layers admit unit-interval models consistent with one common vertex ordering. | [Flu+20; Her+22] |
| Temporally connected graph ($TC$) | Every ordered pair of vertices is connected by a temporal path. | [KKK02; CCS24] |
| Recurrently temporally connected graph ($TC^R$) | Infinite-lifetime analogue of $TC$, where temporal connectivity occurs infinitely often. | [CCS24] |
| Proper temporal graph | Incident edges never share a time label. | [CCS24] |
| Simple temporal graph | Each edge has exactly one presence time. | [CCS24] |
| Happy temporal graph | Both proper and simple. | [CCS24] |
| Temporally transitively orientable graph | Admits an orientation satisfying temporal transitivity for non-decreasing time pairs. | [Mer+21] |
| Strictly temporally transitively orientable graph | Admits an orientation satisfying temporal transitivity for strictly increasing time pairs. | [Mer+21] |

# 3 Evolution-Restricted Classes

**$p$-monotone temporal graphs.** Fluschnik et al. define $\mathcal{G}$ to be $p$-monotone if $p$ is the smallest number such that there are $1 = i_1 < i_2 < \cdots < i_{p+1} = \tau$ and, for each block $[i_\ell, i_{\ell+1}]$, either $E_j \subseteq E_{j+1}$ for all $i_\ell \leq j < i_{\ell+1}$, or $E_j \supseteq E_{j+1}$ for all $i_\ell \leq j < i_{\ell+1}$ [Flu+20]. Thus 1-monotonicity means globally monotone growth or decay, while larger $p$ allows a bounded number of trend reversals.

**Grounded temporal graphs.** The same paper isolates the special case in which one layer contains all others, that is, there exists $i \in [\tau]$ such that $E_t \subseteq E_i$ for every $t$. The paper uses the term *grounded* for this situation in its summary discussion [Flu+20]. This is one of the few cases where temporal $(s, z)$-separation becomes trivial.

**$p$-periodic temporal graphs.** Following edge-periodicity notions already present in the time-varying graph literature [Cas+13], Fluschnik et al. study $p$-periodic temporal graphs, where layer structure repeats with period $p$. In finite lifetime notation, the defining condition is $E_t = E_{t+p}$ whenever $t + p \leq \tau$; equivalently, $\mathcal{G}$ is obtained by repeating a temporal graph of lifetime $p$ [Flu+20].

**$T$-interval connected temporal graphs.** Kuhn, Lynch, and Oshman introduced $T$-interval connectivity in dynamic networks, and Fluschnik et al. import the notion into temporal graph algorithmics [KLO10; Flu+20]. A temporal graph is $T$-interval connected if, for every $t \in [\tau - T + 1]$, the static graph

$$(V, \bigcap_{i=t}^{t+T-1} E_i)$$

is connected. Informally, every window of $T$ consecutive layers has a connected "persistent core". Fluschnik et al. refer to this class informally as "consecutively connected" in their overview [Flu+20].

**$\lambda$-steady temporal graphs.** A temporal graph is $\lambda$-steady if $\lambda$ is the smallest number such that

$$|E_t \triangle E_{t+1}| \leq \lambda$$

for every $t \in [\tau - 1]$, where $\triangle$ denotes symmetric difference [Flu+20]. This captures bounded per-step volatility and is one of the cleanest evolution-only temporal classes in the literature.

# 4 Interval-Layer and Order-Preservation Classes

**Temporal interval graphs.** Hermelin, Itzhaki, Molter, and Niedermeier define temporal interval graphs as temporal graphs whose every layer is an interval graph [Her+23]. This is the direct layerwise lift of interval graphs to the temporal setting.

**Temporal unit interval graphs.** The same authors, in their earlier SAND paper and subsequent journal version, focus on temporal unit interval graphs, where every layer is a unit interval graph [Her+22; Her+23]. This is a proper subclass of temporal interval graphs and was the first interval-based temporal graph class studied systematically in this line of work.

**Order-preserving temporal interval graphs.** Order preservation was introduced by Fluschnik et al. for temporal unit interval graphs and then generalized explicitly to temporal interval graphs by Hermelin et al. [Flu+20; Her+23]. A temporal interval graph is order-preserving if there exists a vertex ordering $<_V$ such that each layer admits an interval model whose left endpoints and right endpoints are both ordered according to $<_V$ [Her+23]. The point is not just that every layer is interval, but that all layers can be represented with one common combinatorial ordering.

**Order-preserving temporal unit interval graphs.** For temporal unit interval graphs, the same common-order idea yields the class of order-preserving temporal unit interval graphs [Flu+20; Her+22]. Hermelin et al. describe the condition informally as requiring "the intervals of every layer to obey a common ordering" [Her+22]. Fluschnik et al. also define the related *shuffle number*, while Hermelin et al. define the *order-preserving vertex deletion* distance; those are parameters, not additional standalone classes.

# 5 Reachability- and Labeling-Based Classes

**Temporally connected graphs ($TC$).** The basic reachability class is the class of temporally connected graphs: every ordered pair of vertices is connected by a temporal path. Equivalently, the temporal reachability graph $\mathcal{R}(\mathcal{G})$ is a complete digraph [KKK02; CCS24]. This class is older than most explicitly named temporal graph classes and is arguably the default global connectivity notion in the area.

**Recurrently temporally connected graphs ($TC^R$).** Casteigts, Corsini, and Sarkar explicitly refer to the infinite-lifetime analogue $TC^R$, where temporal connectivity is achieved recurrently, that is, infinitely often [CCS24]. This belongs more naturally to the time-varying-graph viewpoint than to finite-lifetime algorithmics, but it is a named class and should be recorded.

**Proper temporal graphs.** A temporal graph is *proper* if $\lambda(e) \cap \lambda(e') = \emptyset$ whenever $e$ and $e'$ are incident to a common vertex [CCS24]. In other words, adjacent edges never coexist at the same time. The 2024 reachability paper treats properness as a graph-class restriction rather than merely a path-semantic option.

**Simple temporal graphs.** A temporal graph is *simple* if $\lambda$ is single-valued, that is, every edge has exactly one presence time [CCS24]. Simple temporal graphs already play a role in older papers, but the 2024 paper makes the class explicit and studies its expressivity systematically.

**Happy temporal graphs.** The same paper defines a temporal graph to be *happy* if it is both proper and simple [CCS24]. Although the name is informal, it is not a joke definition: the paper argues that happy temporal graphs are expressive enough to transfer several negative results and should be considered a canonical restricted target class.

## 6 Temporal Orientation Classes

**Temporally transitively orientable graphs.** Mertzios, Molter, Renken, Spirakis, and Zschoche introduce temporal transitive orientations [Mer+21]. An orientation of a temporal graph is temporally transitive if whenever $u \xrightarrow{t_1} v$ and $v \xrightarrow{t_2} w$ with $t_2 \geq t_1$, then there is also $u \xrightarrow{t_3} w$ with $t_3 \geq t_2$. The corresponding class consists of temporal graphs admitting such an orientation.

**Strictly temporally transitively orientable graphs.** The same paper defines the strict variant by requiring the implication only when $t_2 > t_1$, matching strict temporal paths [Mer+21]. The two classes behave very differently: recognition of temporal transitive orientability is polynomial-time, whereas recognition of the strict variant is NP-hard [Mer+21].

## 7 Open-Ended Class Schemas

The literature also contains several sources of temporal graph classes that do *not* form a finite list.

**Layerwise lifts of static classes.** Once one allows definitions of the form "every layer $G_t$ belongs to a static graph class $\mathcal{C}$", one immediately gets an infinite class schema: temporal interval graphs, temporal unit interval graphs, temporal chordal graphs, temporal planar graphs, and so on. Only a few such lifts have been given dedicated study so far; interval-based lifts are the most visible examples [Flu+20; Her+22; Her+23].

**Bounded-parameter families.** Similarly, many papers define structural parameters whose bounded-value instances are themselves graph classes. Examples include bounded shuffle number and bounded order-preserving vertex deletion in the interval literature [Flu+20; Her+23], and bounded temporal cliquewidth, bounded temporal modular-width, and bounded temporal neighborhood diversity in the dense-temporal-graph line [Enr+24]. These are valid temporal graph classes in the formal sense, but not isolated named classes with a finite inventory.

**Distributed time-varying graph hierarchies.** The dynamic-network literature contains a separate hierarchy of classes based on recurrence, periodicity, and connectivity assumptions over possibly infinite executions [Cas+13]. Those classes are important, but mixing that hierarchy into the present inventory without care would conflate two adjacent but distinct literatures.

# 8 Conclusion

Within the narrow but defensible scope of *named* temporal graph classes used in the finite-time algorithmic literature, the list is still surprisingly short. Most explicitly defined classes fall into four families:

- evolution-only restrictions such as $p$-monotonicity, periodicity, interval connectivity, and steadiness;
- per-layer interval restrictions and their order-preserving variants;
- reachability- or labeling-based restrictions such as $TC$, proper, simple, and happy;
- orientation-based restrictions such as temporal transitive orientability.

If one also counts every layerwise lift and every bounded-parameter family, then there is no finite exhaustive list. Any claim of exhaustiveness therefore has to say *within which scope.*

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